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ABSTRACT

This study predicts gymnastic performance, arousal, and anxiety measures from past performances. Pulse rate and the Palmar Sweat Index were utilized as indicants of arousal. Anxiety was assessed by means of the State-Trait Anxiety Inventory. Eighteen members of the Ithaca College women's varsity gymnastic team were tested throughout the 1973-74 competitive season. Regression analysis revealed that past performance loaded most heavily in the prediction equation. Arousal and anxiety measures were of relative unimportance in the regression equation. Any attempt to predict gymnastic performance without taking into account past performance would be folly. (Author)

PREDICTION OF GYMNASTIC PERFORMANCE FROM AROUSAL AND ANXIETY MEASURES

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1. Psychological preparation of the athlete prior to competition has long been a concern of physical educators and coaches. Motivation, stress, anxiety, activation level, and level of arousal have been discussed as significant psychological constructs that either impair or facilitate motor behavior (4, 5, 6, 10). However, few investigations have been concerned with relating different measures of arousal to performance in competitive sport situations (4, 12, 14).

2. The Yerkes-Dodson law, formulated in 1908, posed the following relationship between arousal and motor performance: complex tasks are performed better when one's drive is low and simple tasks are performed better when one's drive is high. The relationship between psychological arousal and subsequent motor performance theoretically takes the form of an inverted-U. As arousal level increases, performance improves up to an optimal point and then deteriorates with further increases in activation. Thus, the level of arousal for optimal performance of one task may not be optimal for other tasks. Gutin (6) classified motor tasks in terms of the degree of inhibition (steadiness) required in the task. Tasks which require the subject to detect and identify many stimuli and then organize

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a response are classified as high in inhibition demand. As the number of stimuli and incorrect responses decrease, the task becomes progressively less demanding in inhibition. According to Cratty (4), distinctions between tasks may be made with reference to three criteria: (1) size of muscles involved, (2) amount of force involved, and (3) magnitude of space in which the movement is performed. In women's gymnastics the four events --balance beam, floor exercise, uneven parallel bars, and vaulting--require the use of different muscle groups, different amounts of space, as well as diverse degrees of inhibition, and therefore should require different levels of arousal for optimal performance.

3. The completed research (5, 18) lends some credence to the hypothesis that emotions, specifically excitement and arousal, might reasonably affect the outcome of some athletic performances. Knapp (8) found that anxiety was detrimental to the performances of novice collegiate gymnastic competitors but had no effect upon the performances of experienced gymnasts. However, an investigation by Bush (3) noted no relationship between anxiety and levels of competition for Springfield College women's gymnastic team. She suggested that further research should involve less proficient gymnasts and combine physiological as well as psychological measures of anxiety. Additionally, Martens (12) stated that the diffusiveness of arousal makes it a troublesome construct to measure and that physiological measures should be coupled with behavioral measures in order to ascertain arousal level.

4. Research (2) has indicated that psychological arousal is associated with certain physiological responses in the body. Two major classifications of responses occur: (1) adrenal gland secretions, and (2)

autonomic nervous system changes. Included within the latter are heart rate, diastolic and systolic blood pressure, electrical conductivity of the skin (GSR), blood volume, finger temperature, respiratory rate, and palmar sweating. Numerous researchers (5, 8, 16) have used these physiological indicators of arousal in their investigations.

5. A new technique for the enumeration of sweat glands was developed by Sutarman and Thompson (21). It involves the counting of the number of holes in a plastic fingerprint made with a moisture-repellent solution. This technique of measuring arousal is known as the Palmar Sweat Index (PSI). Palmar sweating is under autonomic control and is evoked under stressful conditions.

6. Both Martens (10) and Mumford (13) utilized the PSI technique to assess arousal in the performance of a motor skill. The PSI technique has several positive features: (1) its validity has been established; (2) recurring count/recount reliability coefficients in excess of .98 have been reported (7, 10, 21); (3) the record may be permanently stored on a glass slide; (4) the PSI solution is easily transportable and inexpensive; and (5) the simplicity of the administration is one of the PSI technique's most salient characteristics since the entire process takes approximately 15 seconds. In conjunction with the last point the relative unobstrusiveness of the technique makes it especially suited for the collection of data from athletes just prior to competition.

7. The controversial evidence that exists in regard to arousal level and athletic performance may be attributable to individual differences in personality (5, 7, 16). Spielberger (19) proposed a theoretical conceptualization of anxiety phenomena that posits two anxiety constructs. He

suggested that there is a chronic "trait" anxiety which refers to relatively stable, individual differences in anxiety proneness, as opposed to a transient, situational "state" anxiety which may vary in intensity and fluctuate over time (15). In order to measure each of the constructs independently, Spielberger, Gorusch, and Lushene (20) developed the State-Trait Anxiety Inventory. Several researchers (12, 15) have concluded that the STAI is the most sophisticated anxiety assessment instrument from both the theoretical and methodological standpoints, and warrants extensive use in future research in anxiety.

Methods and Procedures

8. Eighteen females who were members of the 1973-74 Ithaca College varsity gymnastic team served as subjects. The four gymnastic events were ranked according to Gutin's (6) inhibition hypothesis and a previous survey conducted by Mumford (14) in which 14 distinguished gymnastic coaches and judges ranked the structure of the four events from predominantly gross to predominantly fine.

9. Resting and competitive levels of arousal were assessed by pulse rate and PSI on five collection dates. No testing was conducted within two days prior to and after competition. After the subject had been seated quietly for two minutes, the PSI solution was applied on the central whorl of the index finger of the left hand. The resultant PSI impression was removed after 15 seconds with the transparent tape and affixed to a glass slide. Competitive arousal levels were assessed within two minutes prior to competition in each of the six gymnastic meets. Scoring the PSI followed the directions of Johnson and Dabbs (7), and was then repeated to assess reliability.

10. The A-Trait scale of the STAI was administered twice within four weeks in a classroom situation. The A-State scale was administered three times to the gymnasts during the competitive season, within 10 minutes prior to competition.

11. The performance scores for each gymnast's event was recorded in whole numbers and tenths and derived from the mean of the judges' scores.

12. Means of the three lowest PSI and pulse rates for each subject were used as the resting levels of arousal. The competitive arousal measures were transformed into standard scores in order to equate these measures with their resting levels (1). The mean gymnastic performance score, standardized pulse rate and PSI scores, mean A-Trait and actual A-State scores, and the actual gymnastic performance scores were subjected to stepwise multiple regression analysis.

13. The present study investigated the relationship between gymnastic performance and several variables--gymnastic skill ability; pulse rate and Palmar Sweat Index as measures of arousal; and state and trait anxiety representing the Ss anxiety proneness.

Results and Discussion

14. A-Trait reliability coefficient was .83. Spielberger (20) had earlier reported reliability of .76. A-State reliability coefficients derived from pre-competition measures ranged from .86 to .88. PSI within-counter reliability was .97 which compared favorably with all previous investigations.

15. The intercorrelation matrix of all variables can be seen in Table 1. Several salient findings can be derived from this table.

Insert Table 1 here

1. No relationship approaches the .80 evidenced between gymnastic ability and gymnastic performance. This certainly should be no surprise since this is the measure of talent or skill ability that the individual possesses or at least has demonstrated under similar competitive situations.

2. The correlation between pulse rate and PSI (.10) was a surprising finding. It appears that two separate aspects of arousal are being assessed and that their relationship is minimal. However, heart rate has been claimed to be one of the most dubious indicants of arousal (9). Additionally the low negative correlations between A-State, pulse rate and PSI (-.22 and -.07 respectively) again reveals limited relationship between these measures.

3. The only arousal measure that reached statistical significance in its relationship with gymnastic performance was pulse rate, but the common variance is extremely low (<8%). However there is somewhat of an inverse relationship between the two variables.

16. The results of Table 2 provide more insight into the question of

Insert Table 2 here

predicting gymnastic performance. The stepwise multiple regression analysis revealed a multiple R, increasing as each variable in order is loaded into the equation. Knowledge of prior performances as indicated by gymnastic ability was the best predictor of gymnastic performance. Pulse

rate, PSI, and A-Trait add to the predictability but only minimally.

17. All of the variables in Table 2 are combined in a regression equation capable of producing an estimate of individual gymnastic performance. The range of the error of estimate was from 1.76 to .02 with 9 observations having a greate than 1.0 error, 18 observations having an error between .50 and 1.0, and 30 observations having less than a .50 error of estimate. Approximately half (53%) of the gymnastic performances could be predicted within ±.50 of the actual scores. Similar predictions, however, could be rendered without the inclusion of the arousal and anxiety measures.

18. The gymnastic events had been ranked from predominantly gross to predominantly fine by a panel of experts, and had also been interpreted according to the inhibition hypothesis. The order of ranking was vaulting, uneven parallel bars, floor exercise, and balance beam. Increased arousal levels should be more disruptive on the beam and floor exercise according to the Yerkes-Dodson Law. None of the correlation coefficients between performance, arousal, and anxiety measures reached statistical significance with the exception of pulse rate and vaulting performance (-.75). This was not in the direction expected since vaulting was deemed to require the least amount of inhibition.

19. There are two large problems with the study.

1. The criterion measure utilized was gymnastic performance and the regression equation is somewhat confounded as a result of the limited reliability of gymnastic judging (17).

2. It is difficult if not impossible to locate any level of arousal on the inverted-U continuum--is it pre-optimum or post-optimum?

Conclusion

20. Any attempt to predict athletic performance without taking into account the skill ability of the performer would be folly. One cannot separate the individual from his or her performance. Arousal and anxiety measures relate to an individual's upcoming performance but not to the extent of taking into account skill ability or past performance.

TABLE 1

INTERCORRELATION MATRIX OF GYMNASTIC ABILITY, AROUSAL MEASURES, ANXIETY MEASURES AND GYMNASTIC PERFORMANCE

Variables	2	3	4	5	6
1. Gymnastic Ability	.19	.05	.01	.31[a]	.80[a]
2. Pulse Rate		.10	-.22	-.26[a]	-.28[a]
3. Palmar Sweat Index			-.07	-.17	-.08
4. State Anxiety				.54[a]	.00
5. Trait Anxiety					.21
6. Gymnastic Performance					

[a] $r_{.05}$, df 56 > .26

TABLE 2

PREDICTION OF GYMNASTIC PERFORMANCE FROM VARIABLES ENTERED IN ORDER OF IMPORTANCE

Variables	R
Gymnastic Ability	.795
Pulse Rate	.806
Palmar Sweat Index	.813
Trait Anxiety	.818
State Anxiety	.818

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